Update on IFPS Science Steering Team (ISST) Activities

Science and Technology Committee Meeting

NWSTC, Kansas City, MO
4 August 2004

ISST and
Brad Colman, ISST Team Leader
SOO, WFO Seattle-Tacoma

Kevin Schrab
ISST Facilitator
Office of Science and Technology

Outline of Presentation

- ISST update and current priorities
- Update on DGEX
- HPC grids (relationship to DGEX)
- Activities on assessing digital forecast process
- Analysis of Record activities
- NDFD IOC Decision Brief action assignments
- National Smart Tools and Smart Initializations Team activities
- Summary comments

ISST Charter

- **Vision --** The IFPS Science Steering Team facilitates an efficient and effective process that allows the NWS to identify, collect, prioritize, and propose focused solutions and recommended courses of action to IFPS science issues. Recognized as a primary conduit between IFP operations and NWS Headquarters, this team of field experts serves to better ensure scientific and technological integrity in the digital forecast process.

- **Roles and Responsibilities**
  - Collect and take ownership of IFPS science issues
  - Define/refine these issues
  - Explore alternatives for solving these issues
  - Recommend proper courses of action

IFPS Science Steering Team

- Brad Colman (WR) – Lead
- Kevin Schrab (OST) – Facilitator
- Mark Jackson (WR)
- Greg Mann (CR)
- Dave Sharp (SR)
- Steve Keighton (ER)
- Eric Stevens (AR)
- Bill Ward (PR)
- Pete Manousos (HPC)

ISST accomplishments over past year

- Identified opportunity to fill SBN "transmission gaps" with transmission of Eta and GFS surface and BL fields
- Investigated and prioritized a spectrum of downscaling possibilities and reported to S&T Committee
- Partnered with EMC to conceive, develop, and champion the Downscaled GFS with Eta Extension (DGEX)
- Worked with MDL on their efforts to develop and distribute COOP MOS (now in GFE; number of MOS sites increased by a factor of 3) and gridded MOS
- Provided scientific critique and feedback into the 10-506 directive process and NVIWT verification plan design
- Input to DSPO Action Teams

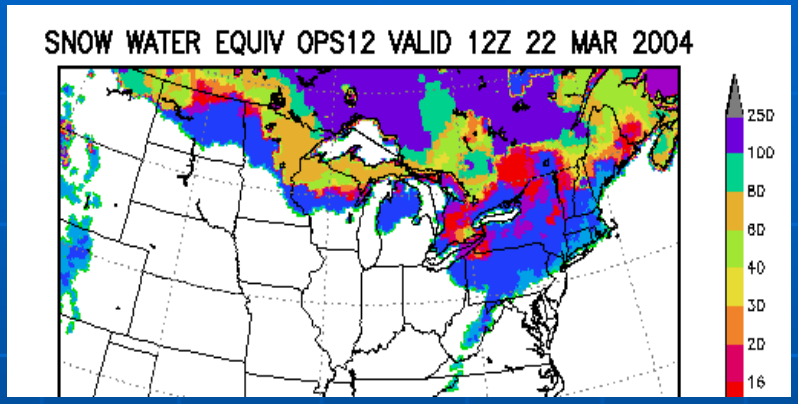
Current ISST Roadmap

- Prioritized list of action topics:
  - Analysis of Record
  - Digital services forecast process (science critical issues)
  - Review of 10-506 (preliminary review to DSPO and OCWWS)
  - Uncertainty and probabilistic information
  - Verification
  - Climatology
  - Downscaling (long-term solutions)
    - Neural nets, MOS, BL-specific models, etc.

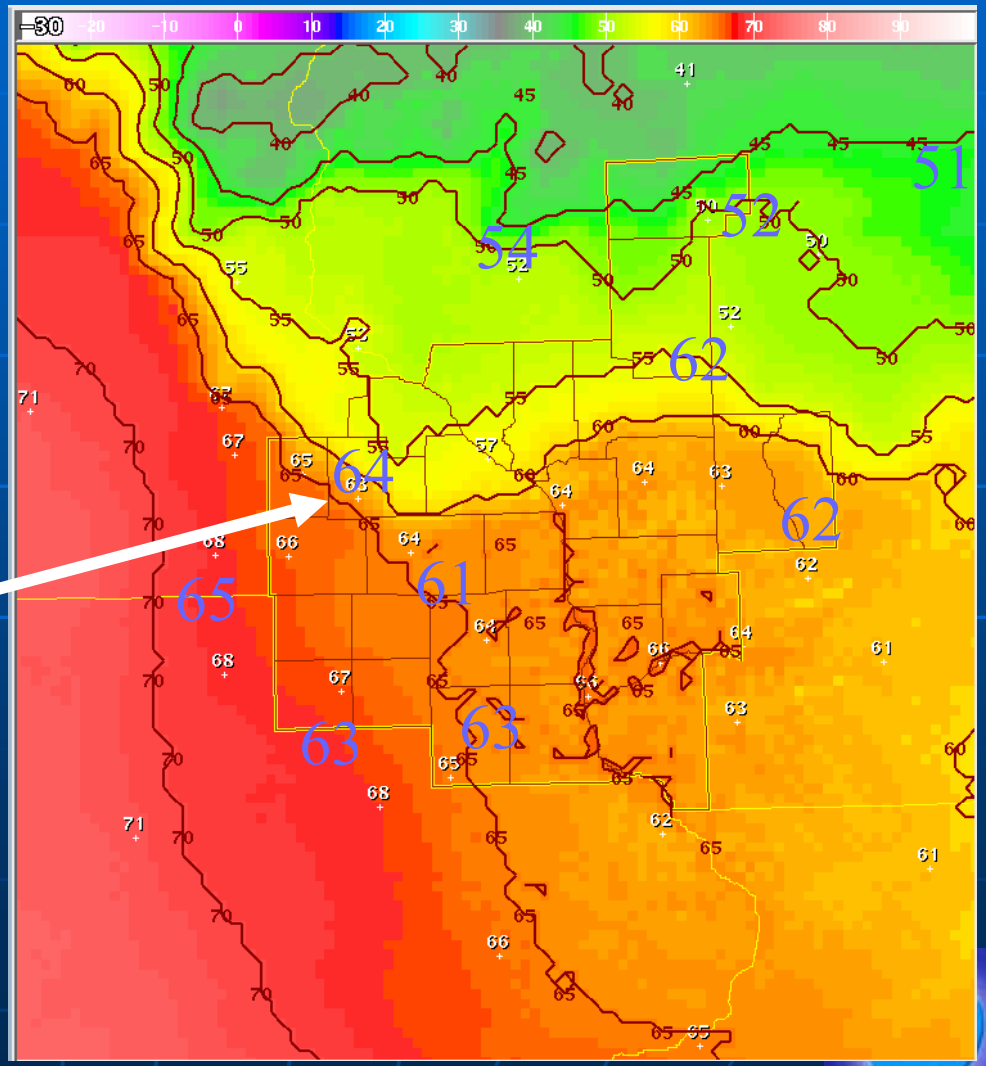
DGEX (Downscaled GFS with Eta eXtension)

- 12-km Eta used as downscaling model (WRF in future)
- Analogous to downscaling GFS since GFS synoptic scale should dominate Eta solution in its interior
- Baseline SmartInit scripts developed by Tim Barker (BOI)
- GFS LBCs; 78-174 hr uses 3-hr LBCs; 174-192 hr uses 6-hr LBCs
- Start DGEX at 78 hr for adjustment (84 hr first time available)
- Provides 12-km data every 6 hours to 192 hours
- Operational cycle times – run twice per day per grid
  - 06Z and 18Z (00Z and 12Z GFS LBCs) for CONUS
    - Available ~0930Z (06Z run) and ~2130Z (18Z run)
  - 12Z and 00Z (06Z and 18Z GFS LBCs) for OCONUS
  - Accommodates 18Z, day 8 grids timeliness deadline

LaCrosse Example – Dan Baumgardt

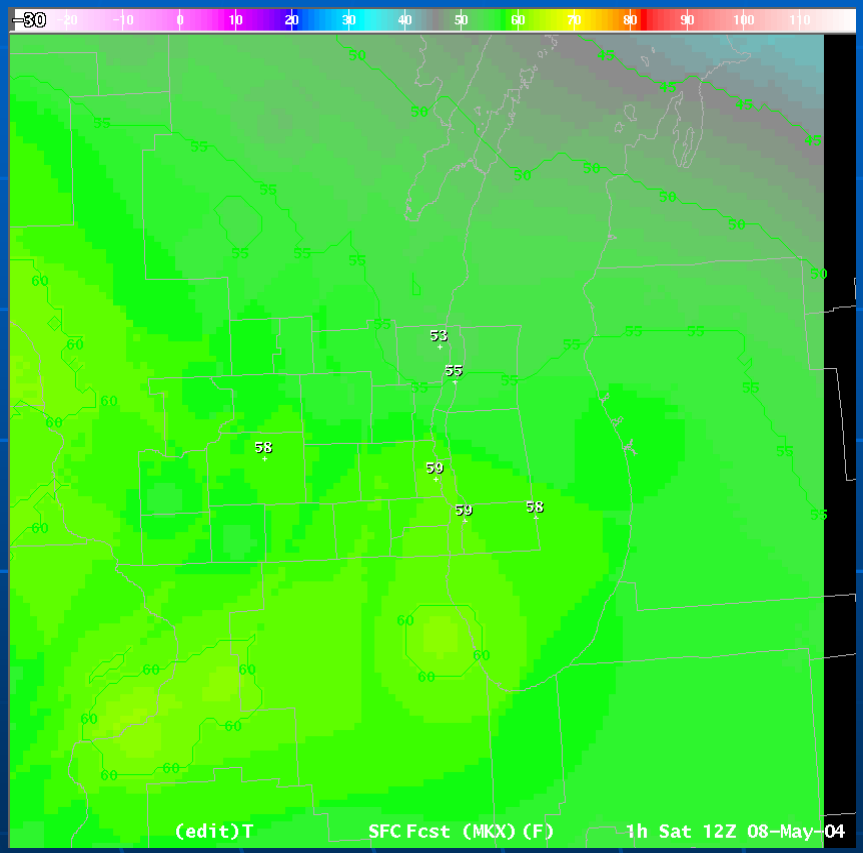


- Eta Snow Cover Reflected in the Day 4 MaxT Grid
- Verified Temps in Blue
- DGEX Very Useful to Modify Forecast MaxT

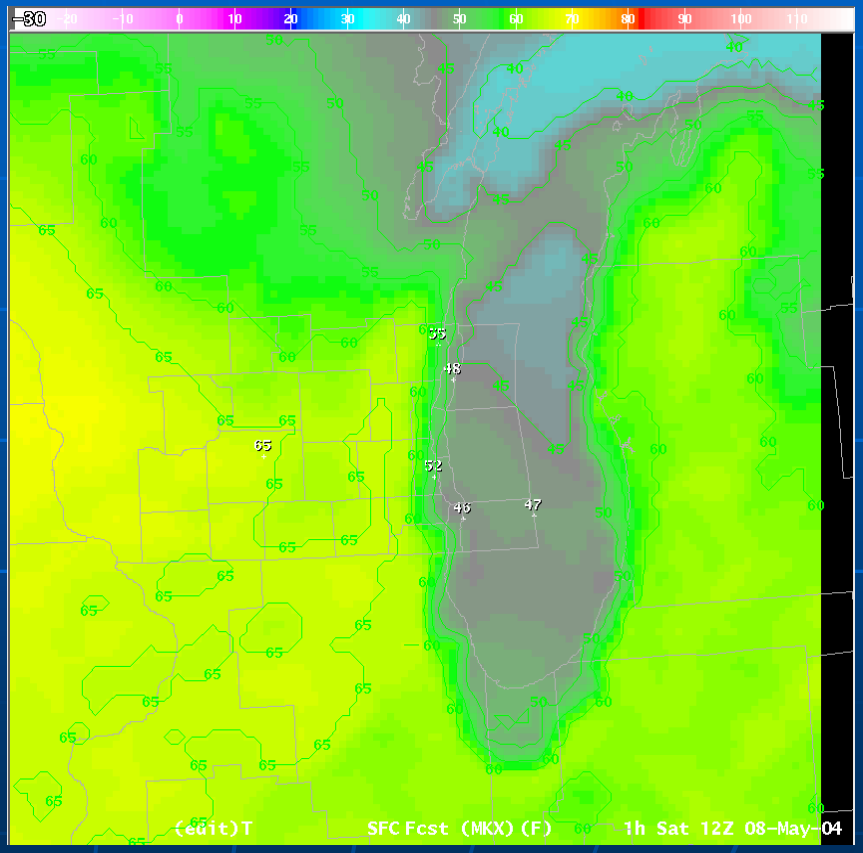


Milwaukee Example – John Eise

Day 6 Forecasts

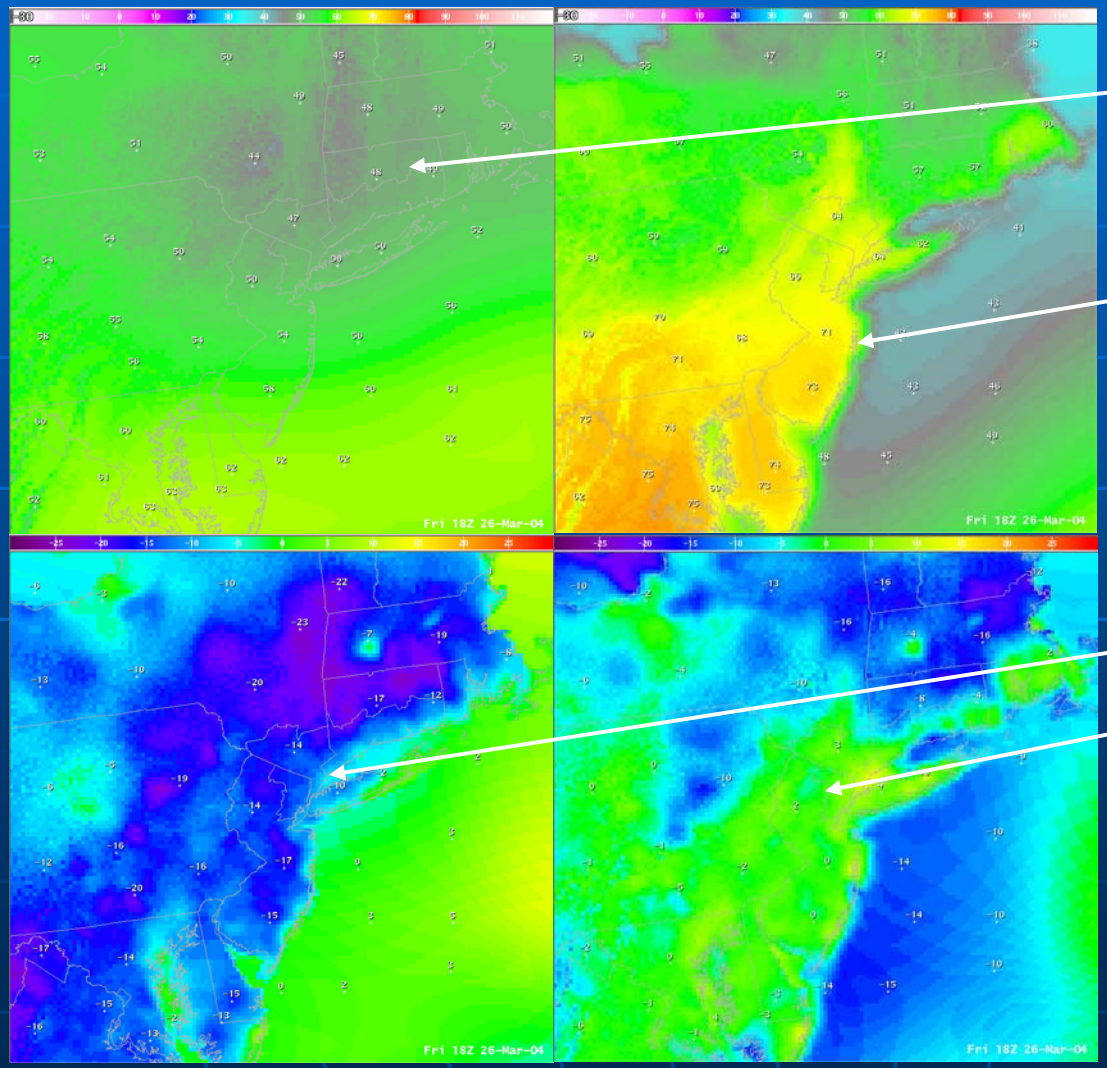


ADJMRF: COOP and MRF MOS



Raw DGEX Surface T

ER Example – Dave Novak



- 90 hr GFS forecast verifying 18Z March 26
- 90 hr DGEX forecast verifying 18Z March 26
- LAPS used as "Ground Truth"
- GFS forecast error
- DGEX forecast error
- DGEX significantly reduces the error

Operational DGEX

- Multi-faceted evaluation conducted by ISST, HPC, and EMC
- Data are currently on the SBN
- AWIPS display capability will arrive with OB3.3 (this month)
- GFE SmartInits will be updated (Tim Barker WFO BOI)
- Stephen Jascourt nearly done with VISITview training session
- Some model biases showing up → AOR and bias removal approaches
- Can be used as background field to apply MatchMOS (see Dave Novak's (ER) page)

  http://www.werh.noaa.gov/SSD/smarttools/newdata/newdata.htm

- Details (e.g., available fields) on ISST page

  http://www.nws.noaa.gov/ost/ifps_sst/

Other New Model Data

- Eta12 Sfc fields thru 84 hrs (since Feb)
- "Full" Eta12, thru 84hrs, 4x/day (OB3.2)
- More GFS levels, thru 240hrs, 4x/day (OB3.2)
- "Full" set of GFS fields on grid 211, thru 240hrs, 4x/day (OB4)
- For details on these RCs, for example OCONUS availability and plans, please see ISST page:

http://www.nws.noaa.gov/ost/ifps_sst/

HPC gridded guidance (ER proposal)

- Allows indirect input of HPC extended forecast guidance into forecast process.
- Needs subjective (i.e., field input) and objective assessment.
  - Must verify beyond MOS points to fully evaluate methodology
- Underscores need for gridded analysis and verification.
- ISST working on a position paper regarding scientific integrity and impact on forecast process.

Activities on assessing digital forecast process (science critical issues)

- Central to ISST charter
- Current activities designed to provide field input to the DSPO
- ISST engaging field in discussion
- Forum effort in May and June not too successful
- Now using Listserv exchanges

Listserv questions

- Team has identified three key questions:
  1. Within the limits of predictability, what is the optimal spatial and temporal resolution needed to provide a useful and versatile digital service while maintaining scientific validity?
  2. What is the best way to minimize discrepancies and produce a near-seamless NDFD while not sacrificing accuracy or efficiency?
  3. How should each NCEP center support WFOs' contributions to the digital forecast process?
- Approach takes advantage of where field staff spend time
- Good response and discussion with first question
- Will be providing summary feedback to DSPO and S&T Committee

Analysis of Record

- ISST has identified this as our number one priority.
- Immediate goal: Determine operational requirements, science and R&D issues that need to be addressed, potential roadblocks, and strategy for implementation. Need to get this on a fast track!
- NWS/OS&T and USWRP co-sponsored a workshop in June organized by John Horel and the ISST.

AOR Summit

- 29-30 June 2004 in Boulder
- NWS/OS&T and USWRP co-sponsored
- Over 70 participants
- Eighteen presentations
- Three break-out groups looking at:
  - Operational requirements
  - Data requirements and verification
  - Approaches (current capabilities and limitations)

Analysis of Record

NWS motivation:

- Real-time seamless verification
- Provide forecasters useful feedback
- Give forecasters a way to assess the initialization and performance of NWP models
- Serves as input to the GFE for use in short-term forecasts
- Contributes to the ongoing development of a gridded climatology
- Building block for new MOS applications
- Hydrology applications

Analysis of Record

Community motivation:

- Mesoscale model development and verification
- Transportation management
- Emergency management and response
- Hindcast testing of data assimilation schemes
- Private sector requirements
- Homeland defense
- Regional climate studies
- Etc.

- Considerations:
  - Be at the same resolution (both spatial and temporal) as the forecast grids
  - Incorporate data from all sources: RAWS, COOP, satellite, radar
  - Be as independent from the NWP models as possible

- Potential directions:
  - A collaborative effort will likely be needed between the NWS, ERL, and universities.
  - Opportunities for outsourcing should be explored
  - External peer-review process will be beneficial
  - A long-term effort is required. Work should begin now, as it will likely be some time before results are available.

Constructively Competing Pressures?

- How can the needs for real-time analyses (with as little time latency as 30 minutes and stringent data cutoffs), be balanced against the needs to provide retrospective analyses of the highest quality possible?
- Given the existing observational limitations, how can the AOR resolve both detailed microclimates as well as define synoptic and mesoscale weather features?
- What elements and quality are required to verify NDFD forecasts compared to other needs for AORs?
- What role is appropriate for 2-dimensional surface analysis approaches in contrast to more complete 3-dimensional data assimilation strategies?
- How can analysis errors due to the biases of the underlying modeling system be minimized?
- How can the uncertainty implicit in any analysis approach be quantified and expressed to the end user?
- What is possible now (using existing resources and technologies), compared to what might be possible in a few years?

Classes of Analyses?

- Provisional real-time analysis (PRTA):
  - An analysis intended to provide within 30m-1h of the valid time the best possible specification of the state of the atmosphere subject to the limitations (data availability, retrieval, QC, etc.) inherent in creating an analysis within such a short time interval
  - Potentially provides F00 NDFD products
  - PRTAs could be surface fields only or fully 3D
- Final real-time analysis (FRTA):
  - An analysis intended to provide the best possible specification of the state of the atmosphere with particular attention placed on the conditions near the surface after at least a 1 day delay in order to allow for data latencies and additional QC
- Retrospective Analyses or Analysis of Record (AOR):
  - An analysis that uses the best available science to define the state of the atmosphere

The Long Term Target…Holy Grail

- AOR: An archive-quality (state-of-the-science) 3-dimensional analysis of base-state and sensible weather elements. Multiple analysis strategies would be utilized as necessary to optimize quality of specific elements. Raw data assets would be archived centrally as a component of the AOR.
  - Frozen through periods of parallel development
  - Documented error (uncertainty) characteristics
  - "system" transferred to operational cycle as appropriate

Is Dec '04 Realistic for PRTA?

- Imposes constraints on process to build business model for AOR
- Eliminates benefits of potential collaborations with push to deliver single product
- Changing the NDFD verification paradigm for forecasters at the transition point
- At a minimum, data assets must be archived beginning December 1 to generate consistent retrospective analyses from the outset of the operational distribution of NDFD products
- What is realistic for EMC or FSL?
- What resources are required?

Preliminary findings and recommendations

- Every effort should be made to proceed rapidly to foster an AOR program that will meet the diverse needs of the environmental community for high spatial and temporal resolution mesoscale analyses.
- The AOR program should be viewed as leading to a suite of consistent products that meet the ongoing diverse needs of the community.
- Community support for an AOR project must be broadened.
- It was noted that ongoing research and development efforts supported by other programs are critical to the future success of the AOR program.
- a Mesoscale Analysis Committee (MAC) should be formed that reports to the Director of the NWS Office of Science and Technology.

Mesoscale Analysis Committee

- Preliminary charge:
  - foster planning and implementation of high spatial and temporal resolution analyses of the atmosphere with particular attention placed on weather and climate conditions near the surface.
  - Efforts should emphasize both real-time operational requirements and state of the science strategies to define an analysis of record.
  - Coordinate with existing working groups within and external to NOAA/NWS.
- Co-chairs? Brad Colman and John Horel
- Order 10 members
- Two subcommittees:
  - Real-time analysis
  - Analysis of Record
- Composition should reflect community constituencies
- Solicit volunteers and nominations. Deadline July 15.
- List nearly compiled and will be submitted to Jack Hayes and USWRP this week

MAC Meetings

- First meeting: mid September
  - Recommend continued development of variational and enKF for WRF
  - Recommend expandable sensor infrastructure and additional sensors (e.g., pressure, wind, RH) be installed as part of COOP Modernization
  - Assess and make recommendations regarding realistic options for PRTA
  - Outline program plan for longer term R&D efforts and development of AOR
- Second meeting: mid April
  - Assess progress on PRTA
  - Finalize implementation plan for AOR

Proposed Timeline from Summit

- July 15: All presentations and preliminary recommendations available online. Deadline for submission of names of volunteers and draftees for AOR committee membership
- August 1: Recommendations for committee members and executive summary of preliminary recommendations made to USWRP/Jack Hayes NWS
- August 15: Form a Mesoscale Analysis Committee
- ~Sept. 15: Committee meeting
  - Assess and make recommendations regarding realistic options for fast track AORs
  - Outline program plan for longer term R&D efforts
- October 15: Draft paper/recommendations submitted for comment to community
- January 1: Final version of paper/ recommendations submitted for publication and to USWRP
- January 1: Preliminary examples of fast track AORs available
- ~March 15: Committee meeting
  - Assess progress on fast-track options
  - Finalize program plan for AOR R&D
- April 15: Rudimentary fast track AORs products available

The time is right…

- COOP Modernization with Ken Crawford
- AMS 1st National Weather and Climate Enterprise Partnership Summit
  - Follows from NRC report "*Fair Weather, Effective Partnerships in Weather and Climate Services*."
  - Part of AMS effort to serve as a neutral host
  - 27/28 July 2004, Dallas-Fort Worth
  - "Developing a National Mesoscale Observing Network: Fundamental Questions."
  - Targets the process necessary to achieve a National mesoscale network
- Immediate and strong need for NWS digital services
- OHD has expressed the Analysis of Record (AOR) will be very beneficial to NWS hydrologic applications, especially river model calibration, and distributed modeling efforts

NDFD IOC Decision Brief action assignments

- General Johnson's action list from 28 June briefing

- ACTION: Design uncertainty information for use in NDFD
  - Has always been on ISST priority list

- ACTION: Create standardized toolkit for QA and other operations
  - Smart Tool Smart Initialization Team (STSIT)

Smart Tools and Smart Initializations Team (STSIT)

ER – Dave Novak (ER-SSD) (Team Leader)

OCWWS – Brian Motta (IFPS Training Team) (Facilitator)

PR – Bill Ward (PRHQ/ ISST)

CR – Gino Izzi (WFO Springfield, MO)

ER – Carl Morgan (WFO Wilmington, NC)

WR – Jim Fischer (Reno, NV)

WR – Carl Gorski (WRHQ)

SR – Brian D. Smith (Little Rock, AR)

AR – Jay Smith (WFO Fairbanks, AK)

NWSTC – Sam Beckman

FSL – Tom LeFebvre

COMET – Stephen Jascourt (NWP PDS team)

MDL- Joe Maloney

Roles and Responsibilities

"This team of field experts serves to ensure the scientific and technological integrity of Smart Tools and Smart Initialization Techniques used in the digital forecast process."

- Collect and take ownership of Smart Tool and Smart Initialization Technique issues, including tool development, verification, use, and training

- Develop process to assure scientific and technical validity of Smart Tools and Initializations

- Recommend tools and techniques for inclusion into the GFE baseline

http://www-md.fsl.noaa.gov/IFPS/nsit/NatSTSITeam.html

STSIT Current Activities

- Identified Current Issues:
  - Smart Tool development, distribution, usage, and training needs to improve; national organizational structure can help
  - Education and training concerning Smart Tools/Initializations, including the scientific use of various Smart Tools in the forecast process
  - need for verification and “proof of concept” for Smart Tools and Initializations
  - need a national perspective (including Alaska and Pacific regions) concerning Smart Tool development issues

Recommended National Tools

- Inspired from success of ER recommended Smart Tools List
- List to contain the most operationally relevant, scientifically sound Smart Tools in use across the NWS
- Expected to help focus training and development resources
- Developed Survey to help identify:
  - national recommended Smart Tools
  - national data and tool needs
- Survey distributed to NWS WFOs (May 24)
- Responses gathered by each Region (June 14)
- Regional responses consolidated into national results (June 28)
- Team analyzing national results (July – September)

STSIT Future Activities

- Quality-assurance tools development and assessment (per General Johnson's briefing).
- Provide DSPO a field, element-by-element assessment regarding operational decision. (Decision must consider forecast accuracy.)
- Establish and maintain National Recommended Smart Tools list.
- Develop process to baseline a subset of recommended tools in official GFE software releases.
- Explore verification of various Smart Tool and Initialization techniques.

ISST Future Activities

- Advocates for AOR – we need your continued support and specifically request initial seed money to form MAC.
- Complete review of 10-506
- ISST Forum in September
- Support and evaluate MDL gridded MOS this fall
- Investigate model bias removal processes
- Continue to work with NSTSIT
- Investigate possible approaches to enhance uncertainty information in our digital services

Background slides

DGEX Parameters

- Pressure at Surface
- Pressure at MSL
- T at 6 Levels: 2m, 0-30mb,30-60mb,60-90mb,90-120mb,120-150mb,150-180mb
- RH at 6 Levels: 2m,0-30mb,30-60mb,60-90mb,90-120mb,120-150mb,150-180mb
- Uwind at 6 Levels: 10m,0-30mb,30-60mb,60-90mb,90-120mb,120-150mb,150-180mb
- Vwind at 6 Levels: 10m,0-30mb,30-60mb,60-90mb,90-120mb,120-150mb,150-180mb
- Total Precip at Surface
- Total Cloud Cover
- Max Temperature at 2meter
- Min Temperature at 2meter
- Terrain height
- Synoptic Parameters (for Assessment of Model Synoptics):
  - 1000 mb - Height
  - 850 mb - Height Temperature Relative Humidity Wind
  - 700 mb - Height Temperature Relative Humidity Wind Omega
  - 500 mb - Height Temperature Relative Humidity Wind
  - 250 mb - Height Wind
  - Lifted Index (Surface Based)

A Community Meeting on Real-time and Retrospective Mesoscale Objective Analysis: An Analysis of Record Summit

Day 1: Tuesday, 29 June

- 8:00-8:15 AM Welcome (Bob Gall USWRP)
- **Session 1: Overview**
- 8:15-8:40 Analysis of Record Issues: Operational Perspective, Brad Colman, Seattle WFO.
- 8:40-9:05 Analysis of Record Issues: Research Perspective, John Horel, University of Utah.
- 9:05-9:25 Summary of Recommendations from USWRP Observing and Regional Weather Prediction Workshops. Fred Carr, University of Oklahoma
- 9:25-9:35 Summary of Recommendations from USWRP Cool Season QPF Workshop. Marty Ralph, NOAA ETL
- 9:35-10:00 Break
- **Session 2: Current Capabilities**
- 10:00-10:15 MSAS/RSAS Patty Miller. FSL
- 10:15-10:30 The NCAR/ATEC Real-Time Four-Dimensional Data Assimilation and Forecast (RTFDDA) System: Basics, operation and future development Yubao Liu. NCAR/RAP
- **Session 3: Data Specific Applications**
- 10:30-10:45 Real-time Doppler wind quality control and analysis. Qin Xu NOAA/NSSL
- 10:45-11:00 Challenges and Prospects for the Analysis of Precipitation Steve Vasiloff. NOAA/NSSL
- 11:00-11:15 Real-Time Hurricane Wind Field Analysis Mark Powell. Hurricane Research Division
- 11:15-11:25 Dave Sharp. Melbourne Fl WFO
- 11:25-11:35 Robert Aune. NOAA/NESDIS
- 11:35-12:45 Lunch

A Community Meeting on Real-time and Retrospective Mesoscale Objective Analysis: An Analysis of Record Summit

Day 1: Tuesday, 29 June (continued)

- **Session 4: Kalman Filter Applications**
- 12:45-1:00 Assimilation of Fixed Screen-Height Observations in a Parameterized PBL. Joshua Hacker NCAR
- 1:00-1:15 Ensemble Filters for Data Assimilation: Flexible, Powerful, and Ready for Prime-Time? Jeff Anderson. NCAR
- 1:15-1:30 Toward a Real-time Mesoscale Ensemble Kalman Filter Greg Hakim. U. Washington
- **Session 5: Future Strategies**
- 1:30-2:00 Analysis of Record Strawman Proposal Geoff DiMego, NCEP.
- 2:00-2:30 An FSL-RUC/RR proposal for the Analysis of Record Stan Benjamin. FSL
- 2:30-3:00 A New Approach for Mesoscale Surface Analysis: The Space-Time Mesoscale Analysis System. John McGinley. FSL
- 3:00-3:15 Break

Breakout Sessions

- Session 1: Analysis Requirements
  - Facilitators: David Ruth & John Snook
  - Charge: Identify and prioritize the requirements for AORs
- Session 2: Observational Resources and Verification
  - Facilitators: Jennifer Mahoney & Eugene Petrescu
  - Charge: Identify and prioritize the observational resources required to generate AORs
  - Identify methods to assess the quality (verification) of the AORs
- Session 3: Analysis Strategies
  - Facilitators: Fred Carr & Steven Lazarus
  - Identify and evaluate the current capabilities to develop AORs
  - Recommend ways that current deficiencies may be overcome

Expanding the Community Support for an AOR

- NDFD verification is a catalyst for these mesoscale analyses, not an end in itself
- Requires developing a compelling business case for an AOR
- Needs a broad awareness of the utility of an AOR
- Ultimate intended to broaden funding base

Stakeholders for AOR (courtesy F. Carr)

- Weather (& climate) community
- North American Carbon Program
- Air quality (State EPA)
- Homeland security
- Agriculture
- Insurance
- Urban management
- Transportation
  - Aviation (Airlines, Corporate Flight Depts, FBOs, Pilots, FAA)
  - Surface (Trucking, State DOT's)
  - Marine (Shipping, Boaters)
  - Railway
- Media
  - Broadcast
  - Print
  - Radio
- Energy
  - Power generation, transmission and distribution
  - Power traders
- Weather derivatives traders
- Financial institutions
- Education
- Research labs
- Consumers
- Recreational

National Recommended Tools

- Team analysis of results based on:
  - Scientific Integrity- Is the tool methodology consistent with meteorological theory and principles
  - Subjective Verification-are there any obvious biases or errors when the tool's results are compared to observations?
  - Usability/Popularity-Is the tool easy to set up and easy for forecasters to use?
  - Hardware Performance- For a baseline GFE system (e.g., 5 km resolution), how long does the tool take to run and are there any GFE crashes?
  - Documentation- Does the tool have documentation which conforms to the National Smart Tool Repository documentation guidelines

National Recommended Tools

- 132 Smart Tools/Inits nominated across the NWS
- Phased Analysis Approach:
  - Phase 1: QC, Grid Population, and Manipulation tools (i.e., not element-specific)
  - Phase 2: NDFD IOC element specific grid editing tools (i.e., Temperature, Dewpoint, Wind, Wave Height)
  - Phase 3: Remaining Tools/Inits (i.e., Wind Gust, Visibility, Mixing Height)